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# (19) (CA) APPLICATION FOR CANADIAN PATENT (12)

(54) Vehicle Emergency Signal Transmission System

(72) Bouliane, Daniel - Canada ;

(71) Same as inventor

(57) 16 Claims

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Notice: This application is as filed and may therefore contain an incomplete specification.

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ABSTRACT

A system for transmitting an emergency GPS (Global Positioning by Satellite) signal from a remote vehicle to a base station; the major improvements being, in the preferred embodiment, that a choice of cellular modem or MSAT™ relay satellite is available to the vehicle computer to communicate with a base computer; that the vehicle computer has an expansion bus accommodating software and hardware customization for various users; that the device is housed in a single protective unit appropriate for a vehicle interior; and that three direct alarm interfaces are available for immediate GPS fix, with the alarm being activated by the driver or by the base computer.

## INTRODUCTION AND DESCRIPTION OF THE PRIOR ART

The present invention is addressed to the problem of emergency signal transmission from remote vehicles, and expected to have greatest use in single-driver vehicles such as taxi-cabs, although it can be of use in other single- or multiple-occupant vehicles. More specifically, it is addressed to such signal transmission when relayed by satellite, so that the drawbacks of cellular transmission are overcome.

The problem of emergency situations in vehicles which range freely over a large area has always been great; whether this means the innuit boy on the stalled snowmobile who froze to death half a day's walk from his home village, or the taxi-driver who doesn't return after shift, the problem is the same: where is he/she? why so late? is something wrong? The advent of radio communications has greatly improved the situation, so that now if appropriate equipment has been installed—such as a two-way radio—a call for help can be made. With the advent of the GPS (Global Positioning by Satellite) even more improvements have been made, since the driver does not need to know or be able to describe the location: they may be lost, but the GPS will still know where they are.

Many systems using GPS have been described in previous patents and commercial releases; a simple example is U.S. patent #5,043,736 (Darnell *et al*, 1991), which specifies a hand-held remote unit that receives GPS data and sends it via a cellular system to a base computer. A more complex discussion of GPS is given in U.S patent #5,223,844 (Manseli *et al*, 1993); but the information flow is much the same.

However there are still drawbacks to the use of commercially-available GPS monitoring systems in specialized situations. The main one is that existing cellular phone systems are extremely limited. The vehicle needs to be within 30 km of a cellular relay tower; and in some parts of the world, such as the United States, cellular areas are maintained by separate companies and travelling into a neighboring area may result in interruption of service. Since by definition an emergency system is something that must

*always* work, this is a serious drawback.

The present invention will overcome this by using a satellite relay between the vehicle and its base computer. Specifically, the MSAT™ (Mobile SATellite link) owned by Telesat Mobile™ Inc., to be launched in 1995, will provide commercially available data relay through its Packet Data™ service. In combination with this satellite, or with others that will likely be launched in future, the present invention will provide vehicles anywhere in North America, and eventually the world, with superior emergency signal transmission. The described embodiment of the invention will be that fashioned for taxi-driver use, and so will incorporate secreted driver-activated alarm triggers (for dangerous situations). Also because low cost is a consideration for most taxi-drivers (and many other users) the described embodiment will be that having an optional transmission using cellular or radio communications; thus if the early commercial costs charged for satellite use are high, the unit will automatically use cellular or radio unless these are unavailable; it will then switch to satellite. Also because of use in dangerous situations (such as criminal assault) the alarm will continue to transmit position data unless deactivated from the base computer, again via the satellite where necessary.

An object of the present invention is to provide for a vehicle emergency signal transmission system comprising the elements of: vehicle positioning data means; vehicle computer means; alarm means; satellite transceiver means; relay satellite means; and base computer means. In this invention the position of a vehicle is transmitted to the base computer means in an emergency situation by the following steps:

(a) vehicle position data is continuously provided to the vehicle computer means by the vehicle positioning data means;

(b) an alarm is signaled to the vehicle computer means by the alarm means;

(c) the vehicle computer means provides continuous vehicle position data and the alarm signal to the base computer means through the satellite transceiver means and the relay satellite means; and

(d) the base computer means deactivates the alarm means by signalling the vehicle computer means through the relay satellite means and the satellite transceiver means.

It is also an object to provide for an invention disclosing a vehicle emergency signal transmission system comprising the elements of:

GPS means, comprising the Rockwell™ International MicroTracker™ (Rockwell™ part #TU-D150-041) module and GPS antenna;

vehicle computer means comprising: system data bus; serial in/out ports; system controller using the Intel™ TS80C188EB microprocessor in the 80 pin PQFP package as a system processor; volatile memory; static memory; real time clock chip with watchdog timer; and expansion bus, comprising a connector and appropriate logic to support an Intel™ AP-96 iSBX expansion bus;

alarm means comprising: alarm button in the vehicle driver's compartment and alarm button in the vehicle trunk;

three alarm interrupt interfaces in the system controller, two of which are connected to the alarm buttons and one of which is addressed through a serial port;

cellular modem means comprising a custom Hayes™ AT command-set compatible 2400 BAUD module and a cellular antenna;

satellite transceiver means comprising: an MSAT™ Packet Data™ compatible satellite transceiver card sending at between 1626.5 and 1660.5 MHz and receiving at a frequency range between 1525 and 1559 MHz; and a satellite antenna;

MSAT™ relay satellite; and

base computer;

wherein an emergency signal is transmitted by means of the following steps:

(a) vehicle GPS data is obtained by the MicroTracker™ module through the GPS antenna on a continuous basis, and a fix is stored in Nonvolatile RAM in the real time clock and updated once a second.

(b) one of the three alarm interrupt interfaces in the system controller is

addressed by an alarm signal generated from the group containing: driver-activated by a button in the driver's compartment; driver-activated by a button in the trunk; automatically activated by time travelled; automatically activated by distance travelled; activated by the base computer by means of a serial in/out port in the vehicle computer.

(c) The system controller registers the alarm.

(d) The system controller obtains current GPS fix if available; if unavailable due to bridge, tunnel, or structural shielding it obtains the fix stored in memory.

(e) The system controller sends the GPS fix and alarm to the cellular modem module, if within range of a cellular tower; or to the satellite transceiver module if not.

(f) Either the cellular modem module or satellite transceiver module sends the alarm and GPS fix, via the appropriate antenna, to the base computer; and does so continuously, with new GPS fix when available.

(g) When the situation has been understood or resolved, but not until, the base station computer sends a coded deactivation message to the vehicle to stop transmitting data.

(h) Optionally, at any time the base station computer sends a break-in message to the vehicle computer and obtains current GPS fix.

(I) Optionally, further instructions, including software, are sent to the vehicle computer from the base station computer, so that the vehicle computer transmits GPS fixes at instructed times, distances, or in instructed formats.

(J) Optionally, the vehicle computer is customized and expanded by means of plugged-in hardware and software, accommodated by the on-board Intel™ AP-96 iSBX expansion bus.

In such a system all physical components of the system that are in the vehicle, except the antennae and alarm buttons, may be together in a single protective housing appropriate to withstand extreme conditions found in a vehicle, such as extremes of humidity, temperature, vibration, magnetic fields, and power supply variation; these

portions in the housing being the GPS receiver module; vehicle computer; alarm means excluding the alarm buttons; cellular modem module; and satellite transceiver module.

## DETAILED DESCRIPTION OF THE INVENTION

For this description, refer to the following diagrams, wherein like numerals refer to like parts:

Figure 1A, a block flow diagram of an embodiment of the invented system;

Figure 1B, a block flow diagram of an alternative embodiment of the invented system;

Figure 1C, a block flow diagram of another alternative embodiment of the invented system; and

Figure 2, a block diagram of the vehicle data bus and attached hardware and processors, of the embodiment illustrated in Figure 1C.

An overview flow diagram of the invented vehicle emergency signal transmission system is generally indicated as 10 in Figure 1A. Vehicle position data 11 is passed to the remote vehicle computer 12 on a continuous basis. When an alarm 13 has been signaled, for instance from a driver panic button (not shown on Figure 1A), the vehicle position data 11 and existence of the alarm signal 13 are passed from the remote vehicle computer 12 to the relay satellite send and receive 14, relay satellite 16, and thereby to the base computer 18. This is a preferred future embodiment; however with the expected initial high cost of satellite connections, a more cost-effective initial route will be followed. One is shown in Figure 1B, where an alternative emergency data transmission system 20 is shown that gives a choice of radio 24a, cellular 24b, or satellite 24c transmission. In most cases in the embodiment shown in Figure 1B (and Figure 1C, a variant) either vehicle computer 22 or base computer 26, or a combination, will make the decision as to which transmit and receive mode to use. This decision could also be made

by a vehicle driver input into the vehicle computer 22, although this input is not shown on the Figures. It will be understood also that the other two combinations, such as emergency transmit system generally indicated as 30 in Figure 1C having the choice between cellular 34a and satellite 34b (i.e., no radio), or between a satellite and a radio (i.e., no cellular) (this possibility is not diagrammed) will also be useful for specific vehicle fleets; in fact the cellular/satellite configuration is expected to be most cost-effective for the initial implementations of the system.

In the foreseeable future the relay satellite 16 shown in Figure 1A, 1B and 1C will be the MSAT™ (Mobile SATellite link) owned by Telesat Mobile™ Inc., with a 1995 launch date projected. Satellite transmit and receive module 14 will communicate with the satellite 16 and hence the base computer 18 using the commercial Packet Data™ service that MSAT™ will carry. The satellite transmit and receive module 14 will transmit at a frequency range between 1626.5 and 1660.5 MHz and receive at a frequency range between 1525 and 1559 MHz.

The alarm 13 may be a physical button (not shown) which would, for instance, be in a secreted place such as under the dash for use in criminal assault or other dangerous situations. In addition, alarm may be generated on the basis of a measurement made by or available to the vehicle computer 12, such as miles travelled, time elapsed, or GPS-determined position. In these cases the vehicle computer 12 would be pre-programmed to generate an alarm when such parameters were reached.

As well as vehicle computer 12-generated alarm functions, the vehicle computer 12 can be called at any time by the base computer 18 and interrogated for GPS data. It can also be continuously monitored when used in fleet management situations.

The embodiment illustrated in Figure 1C in which the vehicle computer 12 has a choice of cellular or satellite communications is shown in more detail in Figure 2 which is a block diagram generally indicated as 40 of an example of a vehicle data bus 42 and various attached hardware and processors, numbered 44 through 56 Note that these components are in general commercially available, and it is the configuration of the

system that is unique. Thus the various parts to be described will appear with different voltages, amounts of memory, and so on, dependent on the specific use or specific commercial logic boards available. In the present example the feeders of and from data bus 42 consist of a:

Power Supply Module 44; nominally of 12V DC input but in practice ranging from 5.5V to 25V DC; with output voltages of +5V and +3V;

Flash (volatile) memory 45; of 512K;

Static RAM (Random Access Memory) 46; of 512K;

Real Time Clock Chip With Watch Dog Timer 47; to initialize the GPS module 50 (described below) after a cold start; to reset the processor; and to report to a base station after specified time intervals;

iSBX BUS (8 Bit) 48; a connector and appropriate logic to support an Intel™ specification AP-96 iSBX expansion bus; providing customization and expansion capabilities for specific customer applications;

System Controller 49; using the Intel™ TS80C188EB microprocessor in the 80 pin PQFP package as a system processor;

Global Positioning by Satellite (GPS) Receiver Module 50; a Rockwell International MicroTracker™ (Rockwell™ part #TU-D150-041);

GPS Antenna 51;

Cellular Modem Module 52; a custom Hayes™ AT command-set compatible 2400 BAUD card;

Cellular Antenna 53;

Satellite Transceiver Module 54; custom or third-party, compatible with the Packet Data™ service that MSAT™ will provide;

Satellite Antenna 55; and

System In Out (I/O) 56; including Alarm, Ignition, RS-232 Port(s), and Status

LED's (these are only listed in Figure 2, not shown graphically)

Two important features of the GPS emergency signal system illustrated in Figure 2 can be expanded upon further. The first is the capability to modify both the hardware and the software inputs into the system data bus 42. The iSBX Bus 48 allows future hardware connections (possibly with built-in software); while the RS-232-Port(s) in the System I/O 56 allow software to be downloaded from a base source, i.e. the base computer 18 shown on Figure 1. This is extremely important, as GPS software vendors have requested a means of adapting user input for specific customer applications.

The second feature of the system illustrated in Figure 2 that may be expanded upon is the operating conditions and hence physical requirements of the housing. A small amount of background may be of use: this embodiment has been designed in response to a request by a labour union representing 15,000 taxi-drivers in three Canadian cities, all of whom can be expected to be working in severely life-threatening conditions for periods of time in mid-winter. In terms of the mechanical and electrical needs of the alarm system, this translates to a set-up that can withstand:

—extended temperatures (-40 to +85°C);

—high humidity and dust;

—constant low levels of vibration and shock;

—strong EMI fields (conducted and radiated);

—power supply input voltage fluctuation (6-24V);

—power supply transient spikes (40V in cars; higher in trucks);

—momentary loss of GPS satellite information; and

—momentary loss of cellular/satellite connection.

To address this need, the system has been designed so that all the numbered components indicated in Figure 2, with the exception of the Antennas 51, 53, and 55, are housed within one protective package small enough to fit under the dash close to the vehicle's electrical panel (since the driver's compartment is usually the most benign

location in a commercial vehicle).

Other requirements of the system controller 49 of Figure 2 include:

—constant standby, even when the vehicle is off;

—low power (due to constant standby);

—multiple alarm inputs (two fixed alarms, one in the trunk and one in the driver's compartment, plus the interrupt from a base station);

—storage of last good fix (due to satellite shadowing by fixed structures);

—remote alarm deactivation (from the base station); and

—self test and system status indicator.

Finally, the antennae are designed to be housed in a single low-profile case.

Operation of the embodiment of the emergency transmission system of the block diagrams, and specifically that of the system with both cellular and relay satellite illustrated by Figures 1C and Figure 2, can be inferred from the foregoing but might be summarized as follows: (in this summary, numerical reference will not be made to the Figures since certain physical characteristics will be included that are not illustrated):

(a) GPS data is obtained by the vehicle GPS receiver module through GPS antenna on a continuous basis, and fixes are stored in memory in Nonvolatile Ram in the system clock and updated once a second.

(b) In an emergency situation, the vehicle driver presses an alarm button in the driver's compartment (or trunk).

(c) The system controller registers the alarm.

(d) The system controller obtains current GPS data if available; if unavailable due to bridge, tunnel, or structural shielding it obtains the last good fix.

(e) The system controller sends the GPS fix and alarm to the cellular modem module, if within range of a cellular tower; or to the satellite

transceiver module if not.

(f) Either the cellular modem module or satellite transceiver module sends the alarm and GPS data, via the appropriate antenna, to the base station computer; and does so continuously, with new GPS data when available. In the foreseeable future, the relay satellite is the MSAT™.

(g) When the situation has been understood or resolved, but not until, the base station computer sends a coded deactivation message to the vehicle to stop transmitting data.

(h) At any time the base station computer can send a break-in message to the vehicle computer and obtain current GPS data.

(I) Further instructions can be sent to the vehicle computer from the base station computer, including software, so that the vehicle computer may transmit GPS data at different instructed times, distances, or in new formats.

(J) The vehicle computer can be customized and expanded by means of plugged in hardware and software, accommodated by the on-board Intel™ AP-96 iSBX expansion bus.

The foregoing is by example only, and the scope of the invention should be limited only by the appended claims.

## CLAIMS

The embodiments of the Invention in which an exclusive property or privilege is claimed are defined as follows:

1. A vehicle emergency signal transmission system comprising the elements of:

vehicle positioning data means;

vehicle computer means;

alarm means;

satellite transceiver means;

relay satellite means; and

base computer means;

in which the position of a vehicle is transmitted to the base computer means in an emergency situation by the following steps:

(a) vehicle position data is continuously provided to the vehicle computer means by the vehicle positioning data means;

(b) an alarm is signaled to the vehicle computer means by the alarm means;

(c) the vehicle computer means provides continuous vehicle position data and the alarm signal to the base computer means through the satellite transceiver means and the relay satellite means;

(d) the base computer means deactivates the alarm means by signalling the vehicle computer means through the relay satellite means and the satellite transceiver means.

2. A system as in Claim 1 which comprises an additional element of cellular modem means, and in which the vehicle computer means provides continuous vehicle position data and the alarm signal to the base computer means through a communication means chosen from the group containing: cellular modem means; satellite transceiver means.

3. A system as in Claim 1 which comprises an additional element of radio means, and in which the vehicle computer means provides continuous vehicle position

data and the alarm signal to the base computer means through a communication means chosen from the group containing: radio means; satellite transceiver means.

4. A system as in Claim 1 which comprises additional elements of radio means and cellular modem means, and in which the vehicle computer means provides continuous vehicle position data and the alarm signal to the base computer means through a communication means chosen from the group containing: radio means; cellular modem means; and satellite transceiver means.

5. A system as in Claim 1 in which the vehicle computer means comprises hardware accommodation means and software memory means, so that said vehicle computer means may be customized and expanded by hardware and by software.

6. A system as in Claim 2 in which the vehicle computer means comprises hardware accommodation means and software memory means, so that said vehicle computer means may be customized and expanded by hardware and by software.

7. A system as in Claim 2 in which the cellular modem means partially comprises a cellular antenna; in which the satellite transceiver means partially comprises a satellite antenna; in which the alarm means partially comprises at least one alarm button; and further in which all elements of the system housed in the vehicle, that is, the vehicle positioning data means; the vehicle computer means; the alarm means; the cellular modem means; and the satellite transceiver means, are together in a single protective housing appropriate to withstand extreme conditions found in a vehicle, such as extremes of humidity, temperature, vibration, magnetic fields, and power supply variation; except that said cellular antenna, satellite antenna, and alarm button(s) are not in said housing.

8. A system as in Claim 6, in which the relay satellite means consists in the MSAT™ (Mobile SATellite link) owned by Telesat Mobile™ Inc.

9. A system as in Claim 6, in which the alarm means comprises having the alarm activated from the group containing: driver activated; automatically activated by time travelled; automatically activated by distance travelled; activated by the base computer.

10. An apparatus for vehicle emergency signal transmission comprising:

GPS (Global Positioning by Satellite) receiver module;

GPS antenna;

vehicle computer means;

alarm means comprising at least one alarm button;

cellular modem module;

cellular antenna;

satellite transceiver module;

satellite antenna;

relay satellite; and

base computer;

in which an emergency signal is generated by the alarm means and communicated by the vehicle computer means to the base computer means via the cellular modem module and cellular antenna when possible and via the satellite transceiver means and relay satellite means when using the cellular modem means is not possible.

11. An apparatus as in Claim 10 in which all portions of the apparatus that are in the vehicle, except the antennae and alarm button(s), are together in a single protective housing appropriate to withstand extreme conditions found in a vehicle, such as extremes of humidity, temperature, vibration, magnetic fields, and power supply variation; said portions in the housing being the GPS receiver module; vehicle computer means; alarm means excluding the alarm button(s); cellular modem module; and satellite transceiver module.

12. An apparatus as in Claim 11 in which the housing is small enough to fit under the dash in the passenger compartment.

13. An apparatus as in Claim 12 in which the vehicle computer means comprises hardware accommodation means and software memory means, so that said vehicle computer means may be customized and expanded by hardware and by software.

14. An apparatus as in Claim 13, in which the GPS module comprises a

Rockwell International MicroTracker™ (Rockwell™ part #TU-D150-041); the vehicle computer means comprises expansion bus means for customization for specific customer applications; the satellite transceiver module uses the Packet Data™ service that MSAT™ will provide; and the relay satellite is the MSAT™.

15. A vehicle emergency signal transmission system comprising the elements of:

GPS means, comprising the Rockwell™ International MicroTracker™ (Rockwell™ part #TU-D150-041) module and GPS antenna;

vehicle computer means comprising:

system data bus;

serial in/out ports;

system controller using the Intel™ TS80C188EB microprocessor in the 80 pin PQFP package as a system processor;

volatile memory;

static memory;

real time clock chip with watchdog timer; and

expansion bus, comprising a connector and appropriate logic to support an Intel™ AP-96 iSBX expansion bus;

alarm means comprising

alarm button in the vehicle driver's compartment

alarm button in the vehicle trunk;

three alarm interrupt interfaces in the system controller, two of which are connected to the alarm buttons and one of which is addressed through a serial port;

cellular modem means comprising a custom Hayes™ AT command-set compatible 2400 BAUD module and a cellular antenna;

satellite transceiver means comprising: an MSAT™ Packet Data™ compatible satellite transceiver card sending at between 1626.5 and 1660.5 MHz and receiving at a frequency range between 1525 and

1559 MHz; and a satellite antenna;

MSAT™ relay satellite; and

base computer;

wherein an emergency signal is transmitted by means of the following steps:

(a) vehicle GPS data is obtained by the MicroTracker™ module through the GPS antenna on a continuous basis, and a fix is stored in Nonvolatile RAM in the real time clock and updated once a second.

(b) one of the three alarm interrupt interfaces in the system controller is addressed by an alarm signal generated from the group containing: driver-activated by a button in the driver's compartment; driver-activated by a button in the trunk; automatically activated by time travelled; automatically activated by distance travelled; activated by the base computer by means of a serial in/out port in the vehicle computer.

(c) The system controller registers the alarm.

(d) The system controller obtains current GPS fix if available; if unavailable due to bridge, tunnel, or structural shielding it obtains the fix stored in memory.

(e) The system controller sends the GPS fix and alarm to the cellular modem module, if within range of a cellular tower; or to the satellite transceiver module if not.

(f) Either the cellular modem module or satellite transceiver module sends the alarm and GPS fix, via the appropriate antenna, to the base computer; and does so continuously, with new GPS fix when available.

(g) When the situation has been understood or resolved, but not until, the base station computer sends a coded deactivation message to the vehicle to stop transmitting data.

(h) Optionally, at any time the base station computer sends a break-in

message to the vehicle computer and obtains current GPS fix.

(I) Optionally, further instructions, including software, are sent to the vehicle computer from the base station computer, so that the vehicle computer transmits GPS fixes at instructed times, distances, or in instructed formats.

(J) Optionally, the vehicle computer is customized and expanded by means of plugged-in hardware and software, accommodated by the on-board Intel™ AP-96 iSBX expansion bus.

16. A system as in Claim 15, in which all physical components of the system that are in the vehicle, except the antennae and alarm buttons, are together in a single protective housing appropriate to withstand extreme conditions found in a vehicle, such as extremes of humidity, temperature, vibration, magnetic fields, and power supply variation; said portions in the housing being the GPS receiver module; vehicle computer; alarm means excluding the alarm buttons; cellular modem module; and satellite transceiver module.

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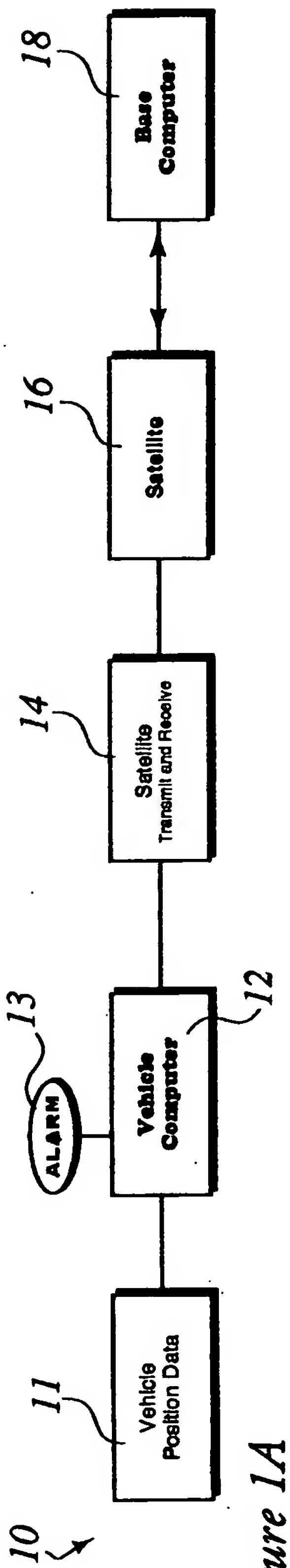


Figure 1A

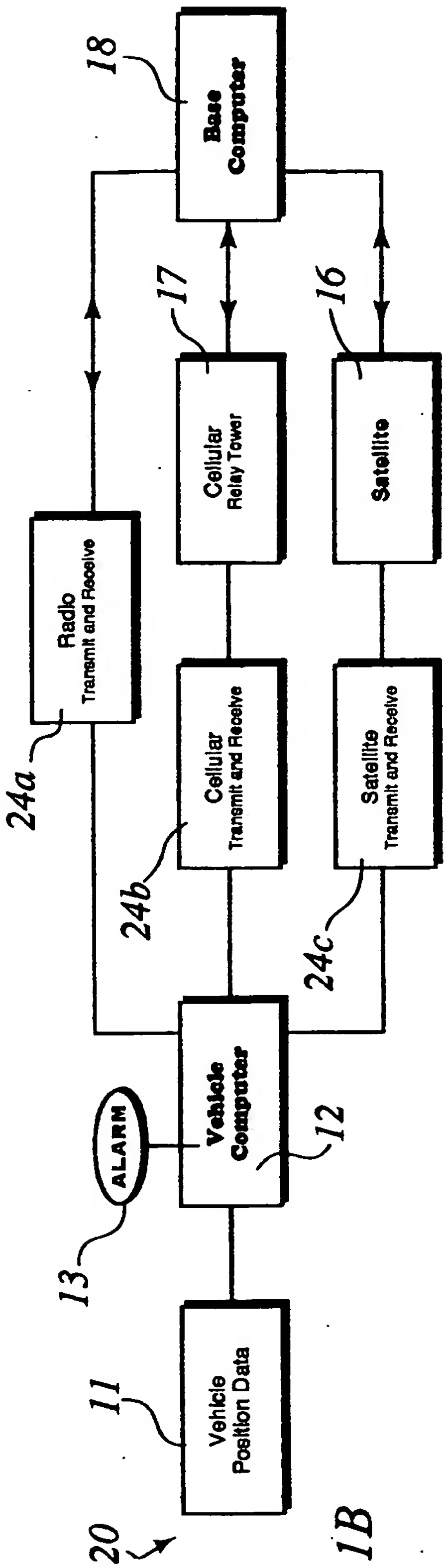


Fig. 1B

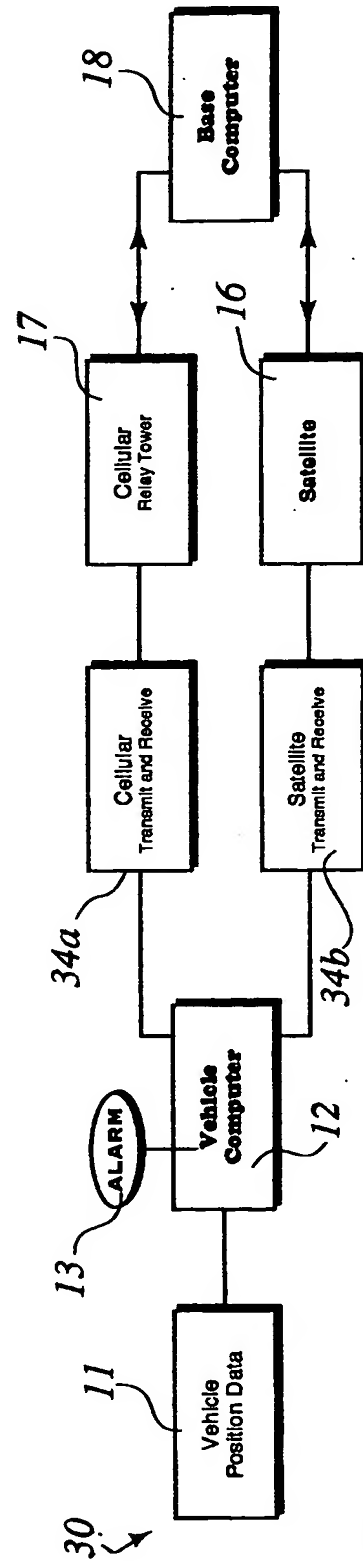


Fig. 1C

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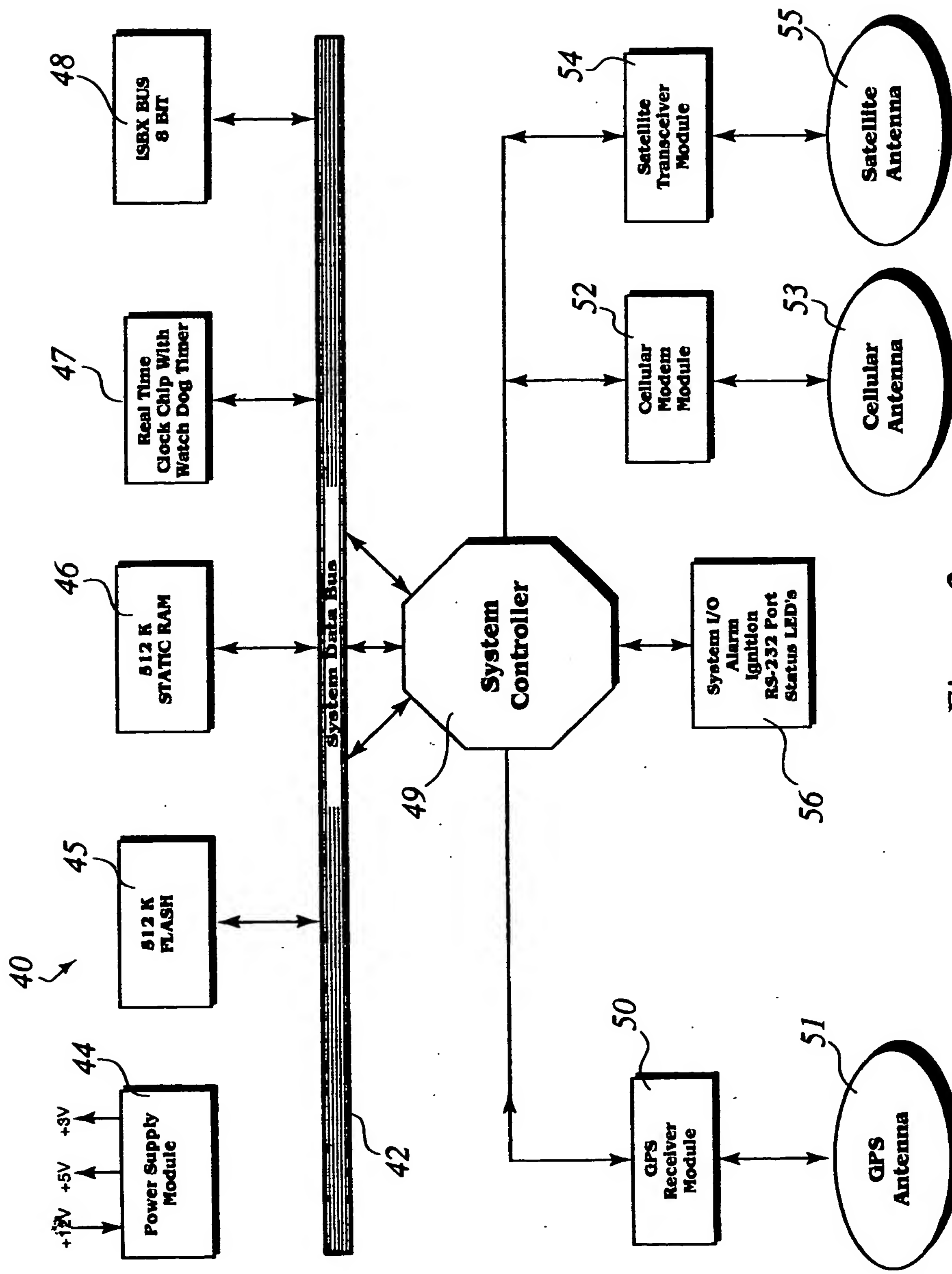


Figure 2

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